To: Tina Laidlaw/MO/R8/USEPA/US@EPA[]
From: "Suplee, Mike"
Sent: Fri 6/8/2012 11:08:47 PM
Subject: Numeric nutrient criteria nondeg rationale
NONDEG_rationale.docx

Hi Tina;

I have prepared and Eric Urban (the new Abe-Bob) has reviewed the first draft of a rationale for our numeric nutrient criteria nondeg policy. Please let me know what you think; this is first draft and we are open to discuss whatever. The nondeg rule language change is summarized in the document, but it can be seen directly on the NWG site too.

Have a nice weekend,

Mike

Rationale for Non-degradation Threshold for Montana Numeric Nutrient Standards DRAFT 1

The state of Montana has drafted new rule language for the application of non-degradation specific to numeric nutrient standards. It modifies ARM 17.30.715 and reads as follows: "The following criteria will be used to determine whether certain activities or classes of activities will result in nonsignificant changes in existing water quality due to their low potential to affect human health or the environment. (d) discharges to surface waters containing total nitrogen and total phosphorus when the resulting concentration outside of a mixing zone designated by the department does not exceed 50% of the base numeric nutrient standards for these parameters" (underline indicating the new rule language being proposed).

Data indicate that, in a great number of cases, increasing concentrations of nutrients affect algal growth or other water quality parameters in a non-linear way. In **Figure 1-1** below, which was developed from long-term data collected on the Clark Fork River (Suplee et al., 2012), nutrient increases from low concentrations (10 µg/L, or 1.0 Log_{10}) to higher ones result in substantial increases in benthic algal growth. But, then, a threshold is reached at about 24 µg TP/L (vertical arrow in the figure) beyond which further nutrient increases do not really control algae density. In this case, phosphorus has reached saturation—relative to the needs of the algae—at about 24 µg TP/L (**Figure 1-1**).

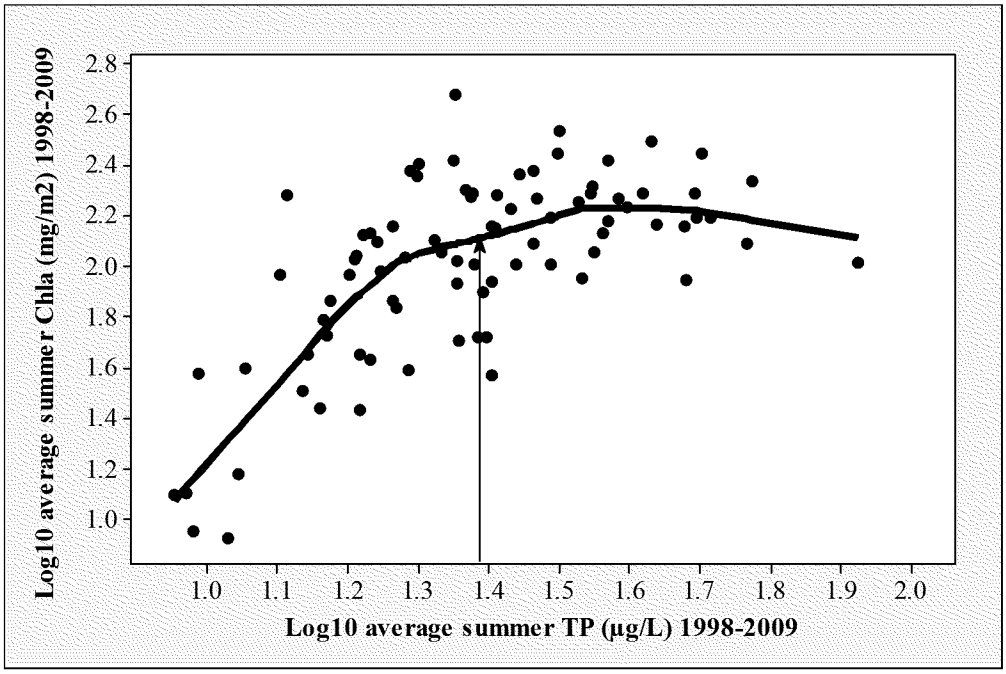

Figure 1-1. Relationship between Ambient River Nutrient Concentrations and Benthic Algal Density in the Clark Fork River, 1998-2009. From Suplee et al. (2012).

Similar results were observed for the lower Yellowstone River, for which the Department has derived numeric nutrient criteria using the QUAL2K water quality model (Flynn and Suplee, 2011; **Figure 1-2**). In this case, pH was one of the most sensitive parameters affected by increasing nutrients and, as can be seen in the progressive nutrient-addition simulations (black dots in the figure), the relationship between

nutrient concentration and pH is also non-linear.

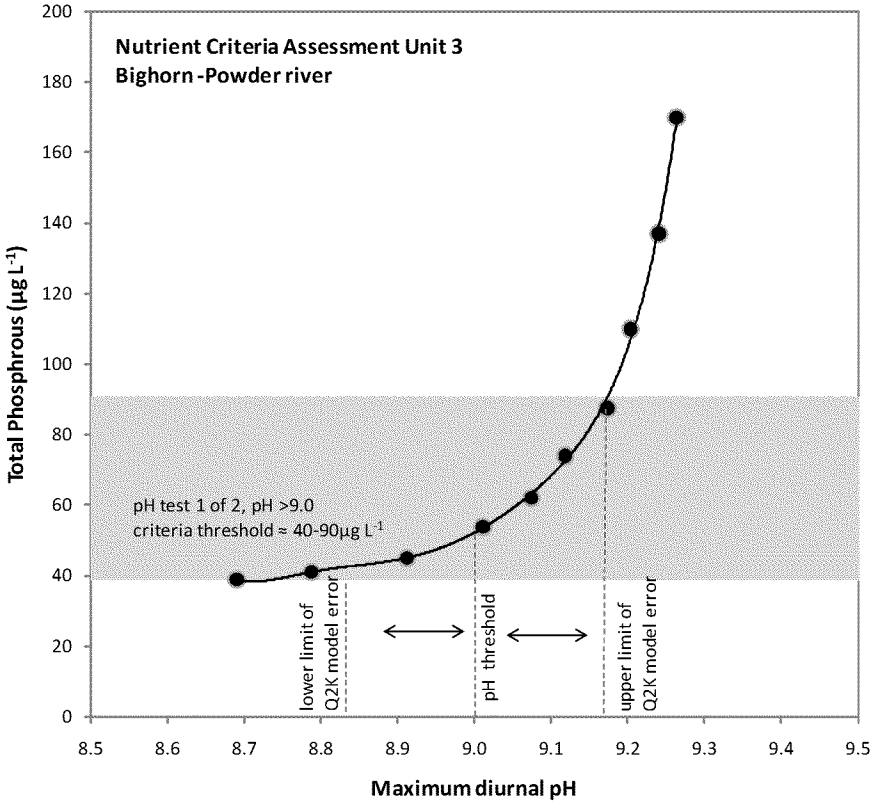

Figure 1-2. Modeled Relationship Between Ambient River Nutrient Concentrations and pH Changes in the lower Yellowstone River, MT.

In most cases, identified harm-to-use thresholds—and therefore the numeric nutrient criteria—occur within the inflection region of the curves (**Figures 1-1** and **1-2)**. For example, on the Clark Fork River a TP criterion of 24 µg/L (near the middle of the inflection, where algal response to TP drops off) is recommended to control benthic algae (Suplee et al., 2012); in **Figure 1-1** this concentration corresponds to 126 mg Chl*a*/m^2 which itself falls between the two benthic Chl*a* standards already adopted for the Clark Fork River (100 mg Chl*a*/m^2 summer average; and 150 mg Chl*a*/m^2 summer maximum). Similarly, for the Yellowstone River, we have recommended a TP criterion of 90 µg TP/L, which matches the upper error limit for the model (**Figure 1-2**; Flynn and Suplee, 2011) and is within the inflection region of the curve. When pH rises to levels > 9.0 there is known harm to fish (Boyd, 1990) and, like the Clark Fork River example, this point occurs at inflection point of the nutrient-parameter curve.

What is clear from these examples is that at very low nutrient concentrations—concentrations well below those which the Department is recommending for numeric criteria—there is usually a rapid response to small increases in concentration. Rapid response of algae (and consequential changes in water quality) to nutrients when nutrient concentrations are low means that virtually any change in

nutrient concentrations would meet the common definition of *significant* (Websters: "Having or likely to have influence or effect; Important; of a noticeably or measurably large amount"). Low nutrient concentrations are commonly observed in Montana's high-quality waters, i.e., those waters to which the state's nondeg policies apply. Yet for such waters, the Department believes that trying to craft an incremental non-degradation policy to control these significant environmental changes to small nutrient changes would not be practicable for base numeric nutrient standards. Year-to-year or month-to-month natural variation, in and of itself, will cause ambient nutrient concentrations in high quality waters to vary and this variation is beyond the realm of regulatory control. For example, TP data has been collected at a long-term reference site in Montana (Blackfoot River, site "Blackfoo_006_C"; Suplee et al., 2005) in July, August, and September, between the years 1979 and 2009 (30 years, n = 52 samples). During this time, the vast majority of the TP data ranged from 3 to 10 µg/L (**Figure 1-3**). Thus, natural TP concentration variation represents between 10% and 33% of the draft TP criterion for the ecoregion (30 µg/L); attempting to limit degradation in these low nutrient ranges would be impractical given the variation that naturally occurs.

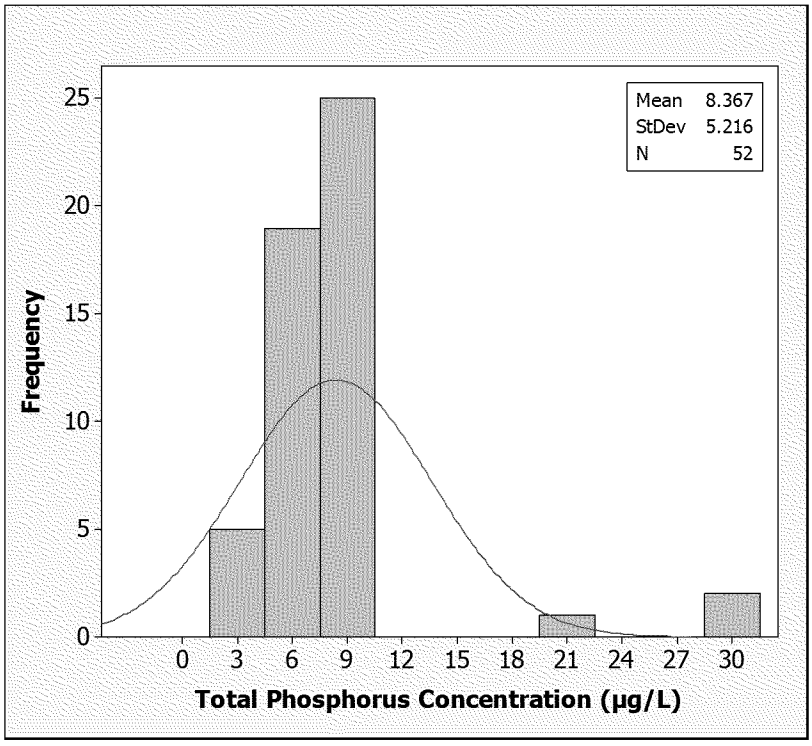

Figure 1-3. July, August, and September Total Phosphorus Concentrations Between 1979 and 2009 at a Montana Reference Stream Site on the Blackfoot River.

In addition, effects on beneficial uses by nutrients may in some cases also be non-linear. For example, a large majority (76%) of the Montana public finds increasingly larger benthic algae levels up to as high as 150 mg Chl*a*/m^2 to be acceptable (i.e., not harming recreational uses), but at the next increment up (200 mg Chl*a*/m^2) public acceptability drops off sharply to 32% (**Figure 1-4**; Suplee et al., 2009). Thus, the recreational use is largely supported up to a tipping point, after which the streams become too

eutrophied, and public acceptance rapidly declines.

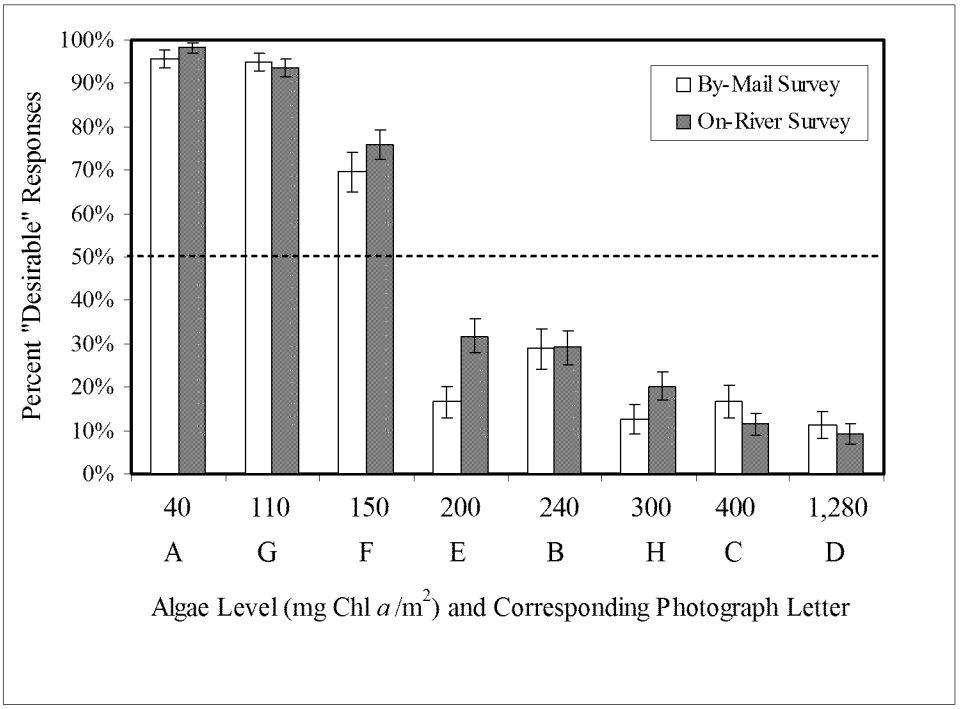

Figure 1-4. Non-linear Response of Public Opinion to Varying Levels of Benthic Algal Density in Montana Streams and Rivers. From Suplee et al. (2009).

The Department's proposed nondegradation non-significant threshold of 50% is, therefore, based on (1) the impracticality of attempting to limit environmental change which tends to be rapid when very small (at times barely measureable) nutrient concentration changes occur, but which are within the natural variation, and which may not lead to demonstrable degradation of the use anyway, and (2) prior precedent in Montana's nondeg rules pertaining to harmful parameters. Regarding the latter, nutrients are currently grouped with toxics in Montana's nondeg rules because, to date, the overarching intent was to control elevated nitrate concentrations in surface and groundwater which can cause a human toxic effect (methemoglobinemia). But the Department will not be changing the nondeg rules for the human-health nitrate standards, and the numeric nutrient standards being proposed are at concentrations far lower than the toxic level for nitrate. There is wide agreement that Montana's proposed numeric nutrient criteria are more reasonably grouped with harmful parameters and, currently, Montana's rules indicate that the maximum allowable change not considered to be significant for harmful parameters is 49% of the applicable numeric standard (ARM 17.30.715[1][f]). This same basic policy (i.e., 50% of the standard as the non-significance threshold) should be applied to the base numeric nutrient standards as well.

REFERENCES

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